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Patent
Case No. U 0236-F02A

TITLE OF THE INVENTION

Method For Extracting Copper From Leach Solutions At Elevated Temperatures

5 CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of copending provisional application serial number 60/470,657 filed on May 15, 2003, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

10 Advances in leaching copper concentrates or high grade copper sulfide ores using either pressure leaching or leaching in stirred tanks with the assistance of ferric ion or bacteria results in leach solutions having a relatively high temperature. The temperatures of most leach liquors treated today is from about 15°C to about 25°C. The leach solutions exiting
15 pressure leach vessels or stirred tanks can be as high as 150°C depending on the leaching technique. For several reasons, including the stability of the copper solvent extraction reagent, there are difficulties in treating leach solutions at these high temperatures via copper solvent extraction. As a result these leach solutions are cooled to not more than about 45 to 50°C
20 prior to entering the copper solvent extraction plant.

In a commercial copper solvent extraction (SX) plant that uses the

elevated temperature leaching technology, the extraction molecule 5-nonylsalicylaldoxime has been used in admixture with 2,2,4-trimethyl-1,3-pentanedioldiisobutyrate, also known by the trade name TXIB. TXIB belongs to a class of compounds called equilibrium modifiers which are

5 disclosed in U. S. patents 4,507,268 and 6,231,784, the entire contents of each of which is incorporated herein by reference. Modifiers alter the normal copper extraction ability of an extractant thereby allowing one to carefully select a blend of 5-nonylsalicylaldoxime and modifier that is optimum or near optimum for a particular copper solvent extraction application.

10 Of concern to operators of copper solvent extraction plants is the hydrolytic degradation of extractants such as 5-nonylsalicylaldoxime since degradation of the extractant represents both an additional cost and an operational problem. The additional cost arises because the reagent lost via degradation must be replaced.

15 The operational problem arises because the degradation of extractants such as 5-nonylsalicylaldoxime is at a higher rate than the degradation of the modifier so that over a period of time the ratio of 5-nonylsalicylaldoxime to modifier in the organic phase in the SX plant slowly decreases. As this ratio decreases the mixture of 5-nonylsalicylaldoxime to

20 modifier will no longer be optimum for the particular copper solvent extraction plant. In order to maintain the mixture of 5-nonylsalicylaldoxime and TXIB at the optimum in the plant both of these compounds must be monitored using sophisticated analytical equipment and then the plant operators must calculate the amount of pure 5-nonylsalicylaldoxime which

25 must be added on a regular basis along with the normal copper solvent

reagent in order to maintain the proper blend of 5-nonylsalicylaldoxime to modifier in the plant organic.

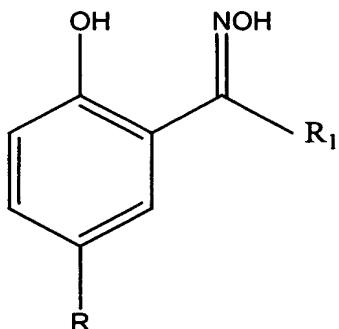
Clearly then there exists a need for a copper extraction molecule that is more stable than 5-nonylsalicylaldoxime in order to reduce reagent loss by

5 degradation and to reduce the number of sophisticated analyses that are required to maintain the proper ratio of copper extraction molecules to modifier.

BRIEF SUMMARY OF THE INVENTION

The present invention pertains to a method for extracting copper from

10 an aqueous copper solution wherein the aqueous copper solution has a temperature of at least 30°C. The method comprises contacting the aqueous copper solution with an extraction reagent of the formula (I)



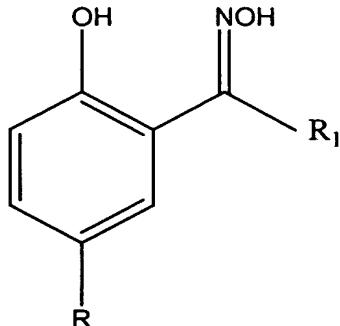
(I)

wherein R is a linear or branched C₁₀₋₁₈ alkyl group and R₁ is H or CH₃. The

15 extraction reagents according to the invention undergo degradation at a significantly lower rate than normally encountered with the use of conventional reagents in leach solutions having temperatures equal to or greater than 30°C.

DETAILED DESCRIPTION OF THE INVENTION

The extractants according to the invention are compounds of the formula (I)



(I)

5 wherein R is a linear or branched C₁₀₋₁₈ alkyl group and R₁ is H or CH₃.

Compounds of formula (I) wherein R₁ is H may be prepared according to methods described in U.S. Pat. Nos. 4,020,105 or 4,020,106 or by oximation of aldehydes prepared according to U.S. Pat. No. 4,085,146, the entire contents of each of which is incorporated herein by reference. Compounds

10 of formula (I) wherein R₁ is CH₃ can be prepared according to the procedures disclosed in UK Patent 1,322,532. Preferred extractants include 2-hydroxy-5-decylacetophenone oxime, 2-hydroxy-5-dodecylacetophenone oxime, 2-hydroxy-5-pentadecylacetophenone oxime, 5-decylsalicylaldoxime, 5-dodecylsalicylaldoxime, and 5-pentadecylsalicylaldoxime and mixtures
15 thereof.

The extractants according to the invention can be and typically are dissolved in a commercial hydrocarbon solvent such as CONOSOL® 170ES, ORFOM® SX 7, ORFOM® SX 12, ORFOM® SX 11, Shellsol 2046 and similar solvents at a concentration greater than about 0.25 M. The

organic extractant may also contain an equilibrium modifier which can include an ester such as 2,2,4-trimethylpentane-1,3-diol diisobutyrate, di-n-butyl adipate, a ketone, an ether, or an alcohol such as tridecyl alcohol. The organic extractant may contain additional oxime extractants. The aqueous

5 feed solution temperature range may be greater than or equal to 30°C, 35°C, or 40°C. The concentration of copper in the aqueous feed solution will typically vary from about 5 gpl Cu to about 50 gpl Cu, most preferably it will be greater than 10 gpl Cu. The leach liquor may result from pressure oxidation of a concentrate or a bio-oxidation process carried out on a

10 concentrate.

The following examples are meant to illustrate but not to limit the invention.

EXAMPLE

A series of stability tests were carried out by continuously stirring an

15 aqueous phase containing 30 gpl (grams per liter) Cu and 180 gpl sulfuric acid with an organic extractant phase at 45°C. Approximately 350 ml of the aqueous phase and 350 ml of the organic phase were placed in a standard 3-neck 1 liter round bottom glass flask fitted with an overhead stirrer motor, Teflon® paddle stirrer and a Friedrigs condenser. The flask was placed in a

20 thermostated oil bath to control the temperature at 45°C. The agitator was set at 480 rpm. Samples of the organic were removed periodically and analyzed for copper max load and for oxime content.

In Test 1, the organic phase was 0.0463 M in 5-nonylsalicylaldoxime, 0.0425 M in 5-dodecylsalicylaldoxime, and 0.104 M in di-n-butyl adipate

25 dissolved in CONOSOL® 170ES. The results are summarized in Table 1.

Table 1

Time (Days)	5-Nonylsalicylaldoxime (m/l)	5-Dodecylsalicylaldoxime (m/l)
0	0.0463	0.0425
56	0.0333	0.0362
84	0.0273	0.0328
112	0.0220	0.0292
139	0.0189	0.0266
168	0.0174	0.0260
196	0.0146	0.0233
224	0.0109	0.0189
252	0.0084	0.0154
260	0.0081	0.0149

Based on the data, 5-nonylsalicylaldoxime has a half life of 5 approximately 115 days, significantly less than 5-dodecylsalicylaldoxime, which has a half life of 220 days under these test conditions.

In Test 2, the organic phase was 0.2640 M in 2-hydroxy-5-nonylacetophenone oxime (Ketoxime), 0.3091 M in 5-nonylsalicylaldoxime (C9 Aldox), and 0.0202 M 5-dodecylsalicylaldoxime (C12 Aldox) in CONOSOL® 10 170ES. The results are summarized in Table 2.

Table 2

Time (Days)	Ketoxime (m/l)	C9 Aldox (m/l)	C12 Aldox (m/l)
0	0.2640	0.3091	0.0202
28	0.2403	0.2253	0.0158
56	0.2243	0.1823	0.0134
84	0.2086	0.1522	0.0123
112	0.1947	0.1274	0.0113
140	0.1833	0.1130	0.0107
168	0.1709	0.1012	0.0098
196	0.1611	0.0928	0.0089
224	0.1529	0.0868	0.0081
252	0.1475	0.0829	0.0078

15 Based on the data, the half life of 5-nonylsalicylaldoxime was approximately 83 days while the half life of the 5-dodecylsalicylaldoxime was

170 days, significantly greater than that of the 5-nonylsalicylaldoxime. The 2-hydroxy-5-nonylacetophenone oxime was significantly more stable than the two aldoximes. It is estimated to have a half life greater than 330 days under these test conditions.